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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/743,982	01/18/2001	Takao Abe	108360	1567

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OLIFF & BERRIDGE, PLC  
P.O. BOX 19928  
ALEXANDRIA, VA 22320

EXAMINER
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ANDERSON, MATTHEW A

ART UNIT	PAPER NUMBER
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1765

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DATE MAILED: 02/04/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

09/743,982

Applicant(s)

ABE ET AL.

Examiner

Matthew A. Anderson

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 30 October 2002.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 20-22, 24 and 27-45 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 20-22, 24 and 27-45 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 01 February 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

**DETAILED ACTION**

***Claim Rejections - 35 USC § 103***

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 20-22, 24, 27-45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Izunome et al. further in view of Wolf et al. (Silicon Processing for the VLSI Era Volume 1: Processing Technology, Lattice Press, Sunset Beach, CA, USA, pp. 1-35, 1986.), Ravi et al. (US 4152536) and Minahan et al. (Conf. Rec. IEEE Photovoltaic Spec Conf. (1982), 16<sup>th</sup>, 310-15).

Izunome et al. discloses the production of single crystalline Si which is doped with gallium and either B or P by the Cz method. In col. 3 lines 25-35 the resistance of the melt is optimized to be 0.001-10  $\Omega$ -cm by the addition of Ga. This also is described as the addition of  $1 \times 10^{18}$ - $5 \times 10^{20}$  atoms /cm<sup>3</sup> of Ga to the melt accounting for evaporation loss from the melt during the pulling process.

Izunome et al. does not disclose a diameter larger than 3" for a Cz crystal of Si doped with Ga.

Wolf et al. discloses the known technology of silicon single crystal formation and doping. Typical interstitial oxygen concentrations in Cz-Si are given as  $5 \times 10^{17}$ - $1 \times 10^{18}$  atoms /cm<sup>3</sup> on page 16. Diameters for typical Cz-Si wafers formed from single crystal ingots are given as up to 200mm (~8 inches). Formation of wafers from Si single crystal ingots by slicing is disclosed on page 23.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine the references because Cz Si (Wolf et al) doped with Ga (known to Izunome) was known in the art to be useful for solar cell formation (Ravi and Minahan). The references provide guidelines for the expected physical properties of the doped Si known to be useful in such devices. The combination of larger ingots of Wolf would provide more surface area for device formation and thus more product produced.

In respect to claims 20, 24, 37, it would have been obvious to one of ordinary skill in the art at the time of the present invention to dope a Cz Si melt contained in a crucible, pulling a Ga-doped Si ingot having a 4" diameter or more, and slicing the ingot to form wafers because Si ingot pulling with diameters up to 8" was known by Wolf et al., Ga doping from 0.001 to 10  $\Omega$ -cm was suggested by Izunome, and Ga doped Si wafers were known by Minahan to be useful in solar cells.

In respect to claim 21, it would have been obvious to one of ordinary skill in the art at the time of the present invention to optimize the atomic concentration per volume of the Si crystal doped with Ga because Izunome discloses that some Ga is lost from the melt due to evaporation and discloses a range (from  $1 \times 10^{18}$ - $5 \times 10^{20}$  atoms /cm<sup>3</sup> of Ga) which gives a range of resistivities.

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In respect to claim 22, it would have been obvious to one of ordinary skill in the art at the time of the present invention to expect Cz-Si to have a interstitial oxygen concentration of  $2.0 \times 10^{18}$  atoms/cm<sup>3</sup> or less because such is described as a typical range for Cz-Si by Wolf et al. and Wolf et al. discloses the need to monitor the property.

In respect to claim 29, It would have been obvious to optimize the area of a solar cell produced from such doped Si wafers because a larger area means more light collection surface and thus more electron flow and because the known Si-wafer diameters from Wolf et al. (at least the 6 in and 8 in sizes) would have provided at least this much area.

In respect to claims 30 and 31, 43-45, one of ordinary skill in the art would have expected a high conversion efficiency in a Ga doped Cz-Si single crystal with the resistivity of between 0.1  $\Omega$ -cm and 5  $\Omega$ -cm because such is suggested by Ravi et al. combined with Izunome.

In respect to claim 32, it would have been obvious to one of ordinary skill in the art at the time of the present invention to use a Si solar cell in space from news releases about the International Space Station, Minahan et al.'s disclosure of the measurement and analysis of radiation resistance in various Si solar cells, and because such a cell would have been anticipated to produce an expected result. The intended use has little effect on the determination of patentability for products.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the Cz method of pulling Ga doped Si single crystals using a

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seed dipped into a melt because such is suggested by the combination of Izunome et al. and Wolf et al.

In respect to claim 38, it would have been obvious to one of ordinary skill in the art at the time of the present invention to dope the melt by charging the crucible with a single crystal highly doped with Ga with Si and forming a melt therefrom because such is suggested by Wolf et al. on page 12, 2<sup>nd</sup> paragraph.

In respect to claim 39, it would have been obvious to one of ordinary skill in the art at the time of the present invention optimize the rotation rate of the crucible because such rotation was described by Wolf et al. on page 15 to effect the chemical uniformity and thermal symmetry, such optimization would have been anticipated to produce an expected result of a more uniform melt, and such optimization would have been achieved with only routine experimentation.

In respect to claim 40-42, it would have been obvious to one of ordinary skill in the art at the time of the present invention to optimize the pressure during the Cz grown process and the amount of gas flowed through the pulling apparatus because Wolf et al. discloses reduced pressure during growth for reducing evaporation from the melt and the control of argon gas flow (page 18 with argon gas shown in Fig. 14), such optimization would have been achieved with only routine experimentation, and would have been anticipated to produce a Cz-Si ingot.

In respect to claims 33-36, it would have been obvious to one of ordinary skill in the art at the time of the present invention, without evidence to the contrary, to conclude that the Ga doped Cz Si wafer having the other properties the same as the applicant's

invention would have also had a very similar low loss of conversion efficiency due to photo-degradation because the applicant has described no special Cz pulling techniques required to obtain such a low loss if conversion efficiency.

### ***Response to Arguments***

Applicant's arguments filed 10/30/2002 have been fully considered but they are not persuasive.

The applicant has provided no evidence for the claim that the conventional Ga doped Cz Si has different conversion efficiencies that of the invention.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). The combination of references discloses known aspects of the Cz formation of Si crystals including Ga doping, size possibilities, resistance as related to the dopant concentrations, and the known use of Ga doped Si as solar cell components. Minahan discloses Ga doped Cz Si for solar cell uses.

The argument that the claims precludes other dopants is not convincing. Claim 20 does not preclude other known dopants besides the specified Ga from the melt.

The argument against Wolf et al. is not convincing. Wolf et al. teaches general principles concerning Si Cz growth that one of ordinary skill in the art at the time of the

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present invention would have been seen as conventional. Since the rejection is based on a combination of references backed up by a motivation, each reference need not teach every limitation as long as the combination does. It does as described above.

The arguments concerning specific properties of Minahan are noted but not convincing. Again the combined references suggest the optimization of resistivity and diameter of Si Cz wafers. Minahan teaches Ga doped Si. (see abstract). The examiner does not have access to the full copy of Minahan et al. only the abstract supplied to the applicants. If the full document is to be considered, an IDS containing it should be submitted.

### ***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of



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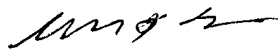
the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew A. Anderson whose telephone number is (703) 308-0086. The examiner can normally be reached on M-Th, 6:30-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin Utech can be reached on (703) 308-3836. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

MAA  
February 1, 2003

  
BENJAMIN L. UTECH  
SUPERVISORY PATENT EXAMINER  
TECHNOLOGY CENTER 1700

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